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(56) Documents Cited

GB 2347952 A	GB 2347950 A	GB 2344606 A
GB 1137310 A	EP 0881354 A	WO 99/35368 A
WO 98/00626 A	US 5924745 A	US 4707001 A
US 4703959 A	US 4648627 A	US 4577895 A
US 4501443 A		

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Online: WPI, EPODOC, JAPIO

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(74) continued overleaf

(54) Abstract Title  
Wellbore casing with radially expanded liner extruded off of a mandrel

(57) An expandable threaded connection includes a first tubular member, a second tubular member and a threaded connection for coupling the tubular members that includes one or more sealing members.

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This international application was published on 21 December 2000. The international search is not available and, therefore, the search incorporated into this document has been made under Section 17.

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**GB 2 355 738 A**



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Application No: GB 0016917.7  
Claims searched: 1

Examiner: David Pepper  
Date of search: 25 September 2000

## Patents Act 1977 Search Report under Section 17

### Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): E1F FJT, FLA

Int Cl (Ed.7): E21B

Other: Online: WPI, EPODOC, JAPIO

### Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X,E	GB 2347952 A (Shell Int Research)	1
X,E	GB 2347950 A (Shell Int Research)	1
X,E	GB 2344606 A (Shell Int Research)	1
X	EP 0881354 A (Sofitech N.V.)	1
X	WO 99/35368 A (Shell Int Research) - see figure 4	1
X	WO 98/00626 A (Shell Int Research)	1

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Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.



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Application No: GB 0016917.7  
Claims searched: 43-52

Examiner: David Pepper  
Date of search: 25 January 2001

**Patents Act 1977**  
**Further Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.S): F2G

Int CI (Ed.7): F16L

Other: Online: WPI, EPODOC, JAPIO

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
A	GB 1137310 A (Commissariat a l'Energie Atomique)	-
A	US 5924745 A (Petroline Wellsystems Ltd)	-
X	US 4707001 A (Seal-Tech Inc) - see col 5, lines 9-37	43-45
X	US 4703959 A (Hydril Co)	43-45
X	US 4648627 A (Dril-Quip Inc) - see col 4, lines 25-39	43-45, 47
X	US 4577895 A (Hub City Works Inc) - see col 2, lines 40-54	43, 44
A	US 4501443 A (Mannesmann Aktiengesellschaft)	-

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Application No: GB 0016917.7  
Claims searched: 59-63

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# Patents Act 1977 Further Search Report under Section 17

## Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): E1F FLA

Int Cl (Ed.7): E21B

Other: Online: WPI, EPODOC, JAPIO

## Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A,P	GB 2344606 A (Shell <u>Internationale</u> Research Maatschappij B.V.)	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
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&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

92, such as aluminum, for example. The outside diameter of the flared out segment 90 is still less than the inside diameter 96 of the casing 98. Ultimately, the flared out portion 90 is to be expanded, as shown in Figure 21, into contact with the inside wall of the casing 98. Since that distance representing that expansion cannot physically be accomplished by the upper end 96 because of its placement below the flared out portion 90, the sleeve 94 is employed to transfer the radially expanding force to make initial contact with the inner wall of casing 98. The upper end 86 of the swage assembly 84 has the shape shown in Figure 22 so that several sections 100 of the tubular 92 will be forced against the casing 98, leaving longitudinal gaps 102 for passage of cement. In the position shown in Figures 21 and 22, the passages 102 are in position and the sections 100 which have been forced against the casing 98 fully support the tubular 92. At the conclusion of the cementing operation, the lower segment 88 comes into contact with sleeve 94. The shape of lower end 88 is such so as to fully round out the flared out portion 90 by engaging mid-points 104 of the flared out portion 90 (see Figure 22) such that the passages 102 are eliminated as the sleeve 94 and the flared out portion 90 are in tandem pressed in a manner to fully round them, leaving the flared out portion 90 rigidly against the inside wall of the casing 98. This is shown in Figure 23. Figure 25 illustrates the removal of the swage assembly 84 and the tubular 92 fully engaged and cemented to the casing 98 so that further completion operations can take place. Figures 24 and 26 fully illustrate the flared out portion 90 pushed hard against the casing 98. Again, in this embodiment as in all the others, auxiliary sealing devices can be used be-

tween the tubular 92 and the casing 98 and the process is done in a single trip.

Referring now to Figures 27-30, yet another embodiment is illustrated. Again, the similarities in the running in procedure will not be repeated because they are identical to the previously described embodiments. In this situation, the tubular 106 is initially formed with a flared out section 108. The diameter of the outer surface 110 is initially produced to be the finished diameter desired for support of the tubular 106 in a casing 112 (see Figure 28) in which it is to be inserted. However, prior to the insertion into the casing 112 and as shown in Figure 28, the flared out section 108 is corrugated to reduce its outside diameter so that it can run through the inside diameter of the casing 112. The manner of corrugation or other diameter-reducing technique can be any one of a variety of different ways so long as the overall profile is such that it will pass through the casing 112. Using a swage assembly of the type previously described, which is in a shape conforming to the corrugations illustrated in Figure 28 but tapered to a somewhat larger dimension, the shape shown in Figure 29 is attained. The shape in Figure 29 is similar to that in Figure 28 except that the overall dimensions have been increased to the point that there are locations 114 in contact with the casing 112. These longitudinal contacts in several locations, as shown in Figure 29, fully support the tubular 106 in the casing 112 and leave passages 116 for the flow of cement. The swage assembly can be akin to that used in Figures 5-11 in the sense that the corrugated shape now in contact with the casing 112 shown in Figures 29 at locations 114 can be made into a round shape at the conclusion of the cementing operation. Thus, a second portion of the swage assembly as

previously described is used to contact the flared out portion 108 in the areas where it is still bent, defining passages 116, to push those radially outwardly until a perfect full 360° contact is achieved between the flared out section 108 and the casing 112, as shown in Figure 30. This is all done in a single trip.

5           Those skilled in the art can readily appreciate that various embodiments have been disclosed which allow a tubular, such as 10, to be suspended in a running assembly. The running assembly is of a known design and has the capability not only of supporting the tubular for run-in but also to actuate a swage assembly of the type shown, for example, in Figure 1 as item 16. What  
10           is common to all these techniques is that the tubular is first made to be supported by the casing due to a physical expansion technique. The cementing takes place next and the cementing passages are then closed off. Since it is important to allow passages for the flow of cement, the apparatus of the present invention, in its various embodiments, provides a technique which  
15           allows this to happen with the tubular supported while subsequently closing them off. The technique can work with a swage assembly which is moved downwardly into the top end of the tubular or in another embodiment, such as shown in Figures 20-26, the swage assembly is moved upwardly, out of the top end of the tubular. The creation of passages for the cement, such as 34  
20           in Figure 8, 76 in Figure 17A, or 102 in Figure 22, can be accomplished in a variety of ways. The nature of the initial contact used to support the tubular in the casing can vary. Thus, although four locations are illustrated for the initial support contact in Figure 8, a different number of such locations can be used. Different materials can be used to encase the liner up

and into the casing from which it is suspended, including cement, blast furnace slag, or other materials. Known techniques are used for operating the sliding sleeve valve shown in Figure 12-15, which selectively exposes the openings 50. Other types of known valve assemblies are also contemplated. Despite the variations, the technique winds up being a one-trip operation.

5

Those skilled in the art will now appreciate that what has been disclosed is a method which can completely replace known liner hangers and allows for sealing and suspension of tubulars in larger tubulars, with the flexibility of cementing or otherwise encasing the inserted tubular into the larger tubular.

10

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made.



Claims

- 5     1.    A method of completing a well, comprising:  
         running in a tubular string into a cased borehole;  
         expanding a portion of said tubular into supporting  
         contact with the casing;  
         delivering a sealing material through at least one  
10    opening in said tubular, with said tubular so supported;  
         closing off said opening.
2.    The method of claim 1, further comprising:  
         expanding said tubular to accomplish said closure  
15    after said delivering of said sealing material.
3.    The method of claim 2, further comprising:  
         using said expanding to close off said opening to  
         accomplish a seal between said tubular and said casing.  
20
4.    The method of claim 3, further comprising:  
         providing a seal downhole of said opening as a  
         backup seal to any seal formed by said expanding.
- 25    5.    The method of claim 1, further comprising:  
         pushing said opening against the casing to close  
         it.
6.    The method of claim 2, further comprising:  
30    accomplishing said running in, supporting,  
         delivering a sealing material, and closing of said  
         opening by expansion, all in a single trip into the  
         well.
- 35    7.    A method of completing a well, comprising:  
         running a tubular string into a cased borehole;  
         expanding portions of said tubular string into

contact with the casing for support thereof;

leaving gaps between said tubular string and said casing, with said tubular string supported to said casing;

5 using said gaps for passage of a sealing material; closing said gaps.

8. The method of claim 7, further comprising:

10 providing longitudinal contact between said tubular string and said cased borehole;

defining said gaps as passages between said longitudinal contacts between said tubular string and said cased wellbore.

15 9. The method of claim 8, further comprising:

using a fluted expansion swage to create said longitudinal contact for support of said tubular string; providing offset flutes on said swage, located one above another;

20 using lowermost flutes to create said longitudinal contact;

using offset flutes to subsequently remove said gaps after passage of said sealing material.

25 10. The method of claim 9, further comprising:

offsetting said offset flutes about 90° from said lowermost flutes.

11. The method of claim 7, further comprising:

30 accomplishing said running in, expanding, leaving gaps, passage of said sealing material, and closing said gaps in a single trip into the wellbore.

12. The method of claim 7, further comprising:

35 providing a seal between said tubular string and said cased borehole by said closing of said gaps.

13. The method of claim 1, further comprising:  
using full circumferential contact for said  
supporting contact.
- 5 14. The method of claim 13, further comprising:  
providing a valve with said opening;  
operating said valve to close off said opening.
- 10 15. The method of claim 14, further comprising:  
providing a sliding sleeve on said tubular string  
as said valve.
- 15 16. The method of claim 7, further comprising:  
running in with a swage inside said tubular string;  
supporting said tubular string while moving said  
swage uphole to expand portions of said tubular string  
into contact with said cased borehole for support  
thereof.
- 20 17. The method of claim 16, further comprising:  
locating a force transfer member inside said  
tubular string during run-in;  
transferring an expansion force from said swage  
through said force transfer member to said tubular  
25 string for said expansion into said cased borehole for  
support thereof.
- 30 18. The method of claim 17, further comprising:  
configuring said swage to force said gaps closing  
through a force transfer through a sleeve which serves  
as said force transfer member.
- 35 19. The method of claim 9, further comprising:  
running in with a swage inside said tubular string;  
supporting said tubular string while moving said  
swage uphole to expand portions of said tubular string  
into contact with said cased borehole for support

thereof.

20. The method of claim 19, further comprising:  
locating a force transfer member inside said  
5 tubular string during run-in;  
transferring an expansion force from said swage  
through said force transfer member to said tubular  
string for said expansion into said cased borehole for  
support thereof.

10

21. The method of claim 20, further comprising:  
configuring said swage to force said gaps closed  
through a force transfer through a sleeve which serves  
as said force transfer member.

15

22. The method of claim 7, further comprising:  
reducing the diameter of a part of a tubing string  
whose original dimension, on said part thereof, was at  
least as large as the inside diameter of a cased  
20 wellbore, to an outer dimension small enough to fit into  
said cased borehole.

23. The method of claim 22, further comprising:  
expanding said portion of said tubing string to its  
25 said original dimension to close said gaps;  
providing said original dimension as larger than  
the inside dimension of said cased wellbore;  
sealing between said tubing string and said cased  
wellbore by forcing said portion of said tubular string  
30 into circumferential contact with said cased wellbore.

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